TO STUDY THE PREVALENCE OF ASYMPTOMATIC HYPERTENSION AMONG ADOLESCENT SCHOOL GOING CHILDREN BETWEEN 10 TO 17 YEARS OF AGE AND TO ASSES THE RISK FACTORS AMONG THEM

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CERTIFICATE

Certified that this dissertation entitled **"TO STUDY THE PREVALENCE OF ASYMPTOMATIC HYPERTENSION AMONG ADOLESCENT SCHOOL GOING CHILDREN BETWEEN 10 TO 17 YEARS OF AGE AND TO ASSES THE RISK FACTORS AMONG THEM"** is a bonafide work done by **Dr.V.PRAKASH, M.D.,** Post Graduate Student of Pediatric Medicine, Institute of Child Health and Hospital for Children, Egmore, Chennai - 600 008, during the academic year 2003 - 2006.

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DECLARATION

I declare that this dissertation entitled **"TO STUDY THE PREVALENCE OF ASYMPTOMATIC HYPERTENSION AMONG ADOLESCENT SCHOOL GOING CHILDREN BETWEEN 10 TO 17 YEARS OF AGE AND TO ASSES THE RISK FACTORS AMONG THEM"** has been conducted by me at the Institute of child health and Hospital for Children, under the guidance and supervision of my unit chief **Prof.Dr.Mallika Pathmananban, MD., DCH.**, and the head of department of Nephrology, **Prof.Dr.Prabha Senguttuvan, M.D.,DCH., D.M.,(Nephro).** It is submitted in part of fulfillment of the award of the degree of M.D (Pediatrics) for the September 2006 examination to be held under the Tamil Nadu Dr.M.G.R Medical University, Chennai. This has not been submitted previously by me for the award of any degree or diploma from any other university.

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CONTENTS

INTRODUCTION

Blood pressure measurement in childhood and adolescence is an important clinical examination as is the recording of body temperature, pulse rate and respiratory rate. Blood pressure raises with increasing age. Both systolic and diastolic blood pressure show a positive correlation with height and weight in both sexes. The underlying process of growth and maturation is closely linked to the BP in children and adolescents.

Even after so much of improvements in the diagnostic techniques, it is often difficult to determine the arterial blood pressure with accuracy in infants and young children. The difficulty encountered is both in the technique and in the interpretation of the reading itself.

Although the prevalence of clinical hypertension is of a far lesser magnitude in children than adults, there is ample evidence to support the concept that the roots of essential hypertension extend back into childhood[1].

The original orientation of physicians with regard to BP in children and adolescents was towards identification and treatment of secondary forms of hypertension, such as renal parenchymal disease and renal artery stenosis. It is now understood that hypertension detected in some children may be a sign of an underlying disease, whereas in other cases the elevated BP may represent the early onset of essential hypertension[2].

Primary prevention of one of the leading health problems like hypertension and ischemic heart disease in adults necessitates a scientific evaluation of the predictors in children and adolescents. Blood pressure studies in these younger age groups provide important epidemiological information which may help in controlling or modifying the risk factors[3] thereby decreasing the mortality and morbidity in the future.

PHYSIOLOGY OF BLOOD PRESSURE

Historical Review

Stephen Hales (Hales, 1733) measured the arterial blood pressure in a horse. He ligated a cannula into an artery, affixed it to a glass tube 9 feet in length and found that the column of blood from the living horse rose about 8 feet above the level of the heart.

He also observed alteration in pressure occurring with each beat of the heart and with movements of respiration.

These observations were of great historical interest, but the method was not very useful because the blood clotted in the manometer in a few minutes[4].

Thus the weight of the column of blood provided a measure of BP. A mercury manometer is more convenient for measuring pressure and it is customary to report the height to which a column of mercury (Hg) is pushed by the intravascular pressure.

Nowadays accurate and continuous records of arterial pressure can be obtained with strain gauge or condenser manometer communicating directly into an artery through a needle or a catheter.

For experimental purposes and during cardiac catheterization in humans, electronic gauges are used which measure pressure wave forms and the mean pressures by means of conductance coils or by a strain gauge attached to a rigid membrane and these gauges are calibrated against a mercury manometer.

DEFINITIONS

Blood Pressure

The blood pressure is the lateral pressure exerted on the walls of the blood vessel by the contained blood while flowing through it[5].

Stystolic Pressure

The systolic pressure is the peak pressure in the arteries during systole[6].

Diastolic Pressure

The diastolic pressure is the lowest pressure in the arteries during diastole[6].

Pulse Pressure

The pulse pressure is the difference between the systolic and the diastolic pressure[6].

Mean Arterial Pressure

The mean arterial pressure is the average pressure throughout the cardiac cycle. Because systole is shorter than diastole, the mean pressure is slightly less than the value halfway between systolic and diastolic pressure. As an approximation, mean pressure equals the diastolic pressure plus one third of the pulse pressure.

PHYSIOLOGICAL ASPECTS OF BLOOD PRESSURE

The following aspects are briefly described below.

I. Determinants of normal blood pressure.

II. Cardiovascular regulatory mechanisms.

III. Factors affecting blood pressure.

IV. Methods of recording blood pressure.

I. Determinants of Blood Pressure

1. Inotropic state of the heart

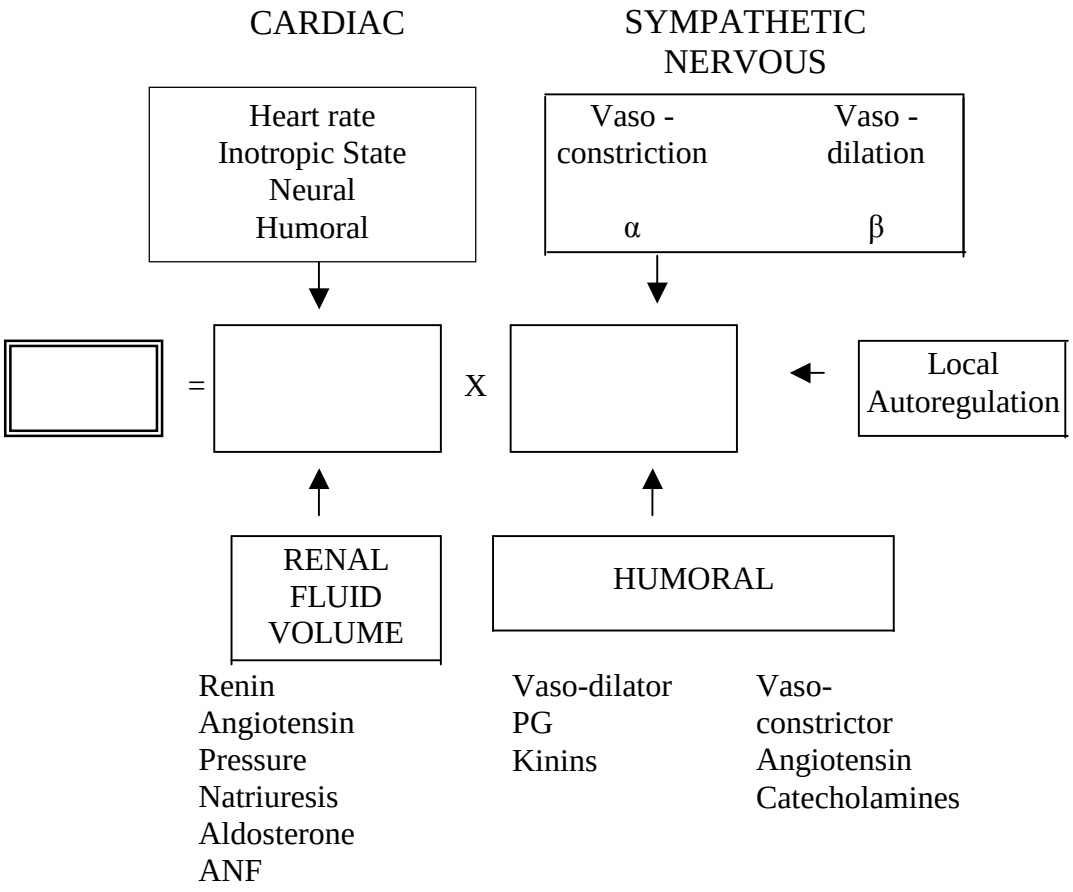
2. Quantity of blood in the vascular system.

3. Peripheral resistance.

4. Viscosity of blood.

5. Elasticity of vessel walls.

Circulatory adjustments are effects by altering the output of the pump (the heart), changing the diameter of the resistance vessels (primarily the arterioles) or altering the amount of blood pooled in the capacitance vessels (the veins).



ANF = Atrial Natriuretic Factor

PG = Prostaglandin

Blood pressure is determined by the product of cardiac output and total peripheral vascular resistance. Cardiac output is controlled by factors such as the heart rate, inotropic state and preload and afterload which in turn are dependent on both neural and humoral influences from the sympathetic and para - sympathetic nervous system and from vasoactive agents[4].

Cardiac output is also dependent on the peripheral factors that influence venous return. The intravascular volume is influenced by renal mechanisms such as sodium excretion (pressure natriuresis) and the renin - angiotensin system[4].

Peripheral resistance on the other hand is determined by neural factors, primarily the sympathetic nervous system's vasodilator and vasoconstrictor mechanisms. It is also influenced by a variety of humoral factors such as prostaglandin's, bradykinins, angiotensin and catecholamines, and it is importantly affected by autoregulation in local vascular beds[4].

II. Cardiovascular regulatory mechanism

1. Baroreceptors
2. Chemorecptors
3. Nervous control
4. Hormonal mechanism
5. Role of skeletal muscles

Baroreceptors

This system consists of stretch receptors located in vessel walls which send information reflecting the level of blood pressure to the central nervous

system which in turn sends efferent impulses to the cardiovascular system which then alter blood pressure.

There are spray type nerve endings lying in the walls of every larger arteries. But they are extremely abundant in the.

i. Walls of internal carotid artery slightly above bifurcation areas known as carotid sinus.

ii. Walls of the aortic arch.

The impulses from each carotid sinus are transmitted through the very small Herings nerve to the glossopharyngeal nerve, thence to the medullary areas of the brainstem. Impulses from the arch of aorta are transmitted through the vagus nerves also to the medulla[6].

The reflexes initiated by the baroreceptors

The baroreceptor impulses inhibit the vaso constrictor centre of the medulla and excite the vagal tone. The net effects are

i. vasodilation throughout the peripheral circulatory system and

ii. Decreased heart rate and force of contraction.

Thus excitation of these receptors by pressure in the arteries reflexly causes the arterial pressure to decrease.

Low pressure conversely has opposite effects causing the pressure to rise. Since the baroreceptor system opposes increases and decreases in the arterial pressure, it is often called as `Pressure Buffer System' and the nerves from the baroreceptors are called `Buffer nerves'.

Chemoreceptors

The chemoreceptors are located in the carotid and aortic bodies which are sensitive to changes in the partial pressures of carbon-dioxide, hydrogen ion and oxygen in the blood.

The arterial chemoreceptors play an important role in the control of respiration and are thought to be of relatively minor importance in the control of the circulation.

The major cardiac effects of stimulation of the arterial chemoreceptors are profound bradycardiac, conduction defects and a diminution of cardiac contractility.

Although the reflex effect of stimulation of the carotid bodies is primarily inhibitory (bradycardia), stimulation of the aortic bodies causes an increase in heart rate and ventricular function.

Control of arterial pressure by the vasomotor centre

When blood flow to the vasomotor centre in the lower brain stem becomes decreased enough to cause ischemia, the neurons in the vasomotor centre themselves respond directly to this ischemia and become strongly excited.

When this occurs the systemic arterial pressure often raises to a level as high as the heart can possibly pump. This effect is believed to be caused by failure to remove carbon-dioxide from the vasomotor centre. The local concentration of carbon-dioxide increases greatly and has an extremely potent effect in stimulating the sympathetic nervous system.

Role of skeletal muscles

The resistance vessels of skeletal muscles are innervated by vasodilator fibers, which although travel with the sympathetic nerves, are cholinergic (the sympathetic vasodilator system)[4].

Skeletal muscle increases cardiac output and arterial pressure by

i. abdominal compression reflex

ii. increased mean circulatory filling pressure caused by skeletal muscle contraction during exercise.

Local regulatory mechanism

The capacity of tissue to regulate their own blood flow is referred to as `Auto regulation'.

Most vascular beds have an intrinsic capacity to compensate for moderate changes in perfusion pressure. By appropriate changes in vascular resistance, the blood flow remains relatively constant at the local level. This capacity is well developed in the brain and the kidneys, but it has also been noted in the mesentery, skeletal muscle, liver and myocardium.

It is probably due to intrinsic contractile response of smooth muscle to stretch reflex (myogenic theory of autoregulation).

Vasodilator substances tend to accumulate in active tissues and these `metabolites' also contribute to autoregulation (metabolic theory of autoregulation)[6].

Factors affecting caliber of the arterioles

Vasoconstriction

1.	Local Factors	:	↓ Local temperature Auto regulation
2.	Local Hormones	:	Endothelin-1 Platelet serotonin
3.	Circulating Hormones	:	Epinephrine (Except in liver and skeletal muscle) Norepinephrine Angiotensin II Circulating Na^+ K^+ ATPase inhibitor Neuro Peptide Y
4.	Neural factors	:	↑ Discharge of noradrenergic vasomotor nerves

Vasodilatation

1.	Local Factors	:	↓ CO_2 and ↑O_2 ↑ K+, Adenosine, Lactate, etc. ↓ Local pH ↑ Local temperature
2.	Local Hormones	:	Nitric oxide and kinins
3.	Circulating Hormones	:	Epinephrine in skeletal muscle and liver Substance P, Histamine Vasoactive intestinal peptide

			Atrial Natriuretic Peptide
4.	Neural factors	:	↓ Discharge of noradrenergic vasomotor nerves Activation of cholinergic dilator fibers to skeletal muscles

The natural history of blood pressure in children

Blood pressure is considerably lower in children than adults but always increases steadily throughout the first two decades of life[7].

Blood pressure begins to follow a pattern during the preschool years that is a child falling within a certain percentile group. Blood pressure distribution tends to be within the same percentile as they grow older. The pattern continues from adolescence into adults life, which supports the hypothesis that essential hypertension begins in childhood. Growth and maturation are the strong determinants of normal pressure throughout the childhood and adolescence.

Obese and taller children have higher blood pressures than smaller and lean children. A direct relation between weight and blood pressure has been documented as early as five years of age. Height age rather than chronological age is a better correlate of blood pressure during adolescence, a time when there is tremendous variability in growth and maturation.

Blood pressure is slightly higher in boys than girls during the first decade of life. This difference begins to widen around the onset of puberty and blood pressure is significantly higher in young men by the end of the second decade.

A familial influence on blood pressure can be identified early in life. Children from families with hypertension tend to have higher blood pressure than children from normotensive families.

Siblings of children with high blood pressure have significantly higher blood pressure than siblings of children with low blood pressure. There is a greater correlation in blood pressure between mothers and their children than between fathers and their children suggesting a direct prenatal influence.

Blood pressure measurement

A best measurement of blood pressure is an estimate rather than precise determination since a number of physiologic variations some of which cannot be controlled are operative. Systolic pressure varies diurnally with an early morning low point and early evening high point. During sound sleep, the systolic pressure decreases[4].

GENERAL PRECAUTION

Errors in measurement may be in any of the following.

i. the patient

ii. the instrument

iii. the technique of measurement

iv. the examiner.

Many of these errors can be alleviated or completely controlled with some added care and patience.

The Patient

The blood pressure varies considerably with phase of respiration, crying, laughing, anxiety, recent activity and abnormal body temperature. Thus it is important to reassess the patient and to allow time for recovery from apprehension or recent activity.

The Instrument

Blood pressure in children is most conveniently measured with a standard clinical sphygmomanometer. Errors may be due to defective instrument in the form of leakage, improper valve function, dirty tubes and oxidation of mercury.

The Technique

Correct measurement of BP in children requires the use of a cuff that is appropriate to the size of the child's right upper arm. The cuff bladder width should be approximately 40% of arm circumference midway between the olecranon and the acromion which usually covers 80% to 100% of the arm circumference.

Mercury column of the sphygmomanometer should be vertical and eye of the examiner should be at the level of meniscus. The right arm is preferred for consistency and comparison with standard tables.

Too narrow a cuff will result in error on higher side and vice versa. Use of a narrow cuff requires a higher inflation pressure to compress the artery. With use of a cuff which is too wide, a large segment of the vessel is compressed

resulting in an increased resistance to flow and a tendency for the pulse to disappear before it reaches the lower edge of the cuff.

The common impression that arterial pressure is higher in legs than arms is a misconception and probably reflects the use of cuff of inadequate width. While recording BP in a sitting position, the forearm is best placed on a smooth surface at heart level[2].

The Examiner

It is not generally appreciated that many observers introduce a subjective error. It is recommended that average of atleast two reading of systolic and diastolic pressure be accepted as the final estimate. Studies have shown that there is a great preference for zero as the terminal digit.

The Principal factors that can affect the accuracy of BP measurement in children[10]

1. Cuff bladder width and length
2. Sphygmomanometer used
3. Stethoscope head and placement
4. Demographics
5. Number of BP measurement
6. Time and place of measurement
7. Season of the year
8. Temperature
9. Surroundings

10. Number and frequency of BP measurement
11. Subject posture and arm position
12. Order of blood pressure measurement
13. Fasting or nonfasting state
14. Choice of fourth or fifth phase of Korotkoff sounds to define diastolic BP.

Among all the factors mentioned above, cuff bladder size and position of the subject are very important. The cuff bladder size is selected according to the midarm circumfernecnce.

METHODS OF RECORDING BLOOD PRESSURE

a. Direct intra arterial method

b. Indirect methods

   i. Palpatory method

   ii. Auscultatory method

   iii. Flush method

iv. Doppler method

v. Oscillometric method using automated devices

A. Direct Arterial Method

When a catheter which is inserted directly into an artery, is filled with saline, the pressure wave form is transmitted from the catheter tip and this wave form can be recorded electronically by means of a transducer.

The typical transducer of the strain gauge type has a fluid filled chamber which covers a thin metal diaphragm. The transducer should be calibrated with a standard mercury manometer to allow measurement of absolute pressure and it is important to set the reference level of the gauge to zero atmospheric pressure at the level of the heart.

Pressure recorded through such a catheter transducer system are subject to some artifact from the microbubbles in the catheter or transducer and these must be carefully removed before use.

INDIRECT METHODS

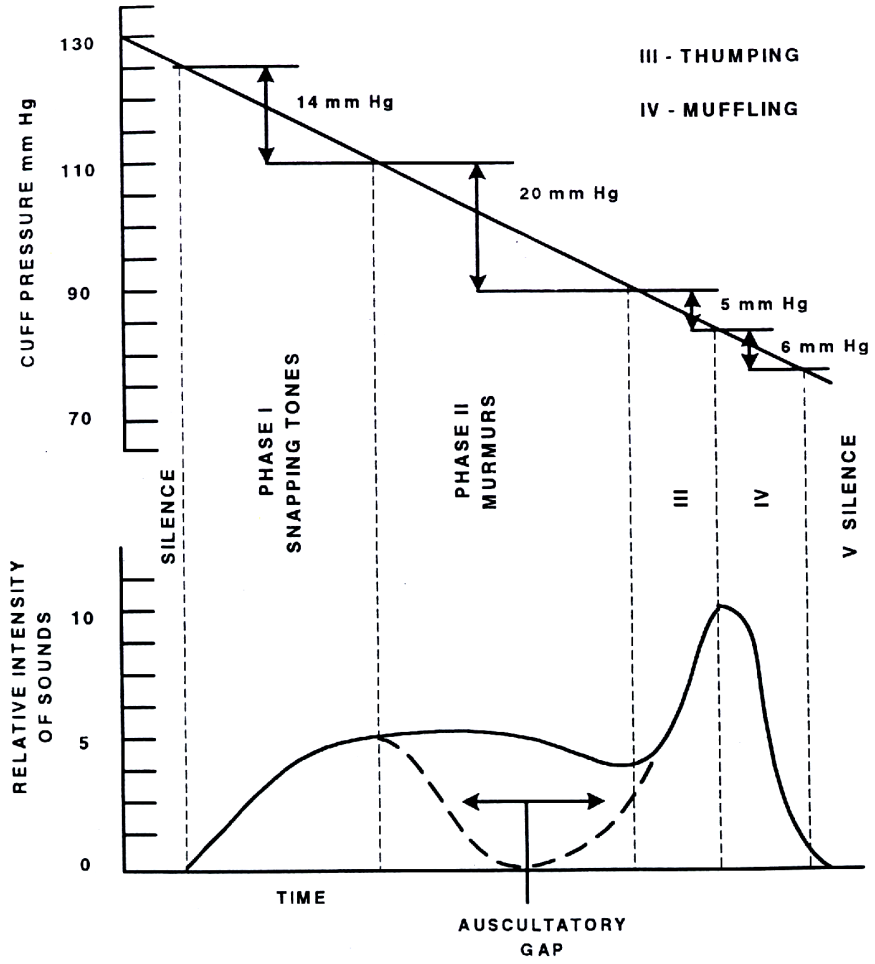
Palpatory Method

By palpation we can record only the systolic blood pressure which is usually 4-6mm Hg less than the auscultatory method.

Auscultatory Method

The majority of blood pressure nomogram is based on ausculatory method. However in small infants the vascular sounds are often too faint to permit accurate interpretation. So other methods are preferable.

An appropriate sized cuff is placed on right upper arm. Pressure in the cuff is first inflated above the level of systolic pressure in the aorta which collapses the artery, and as one listens over the brachial artery in the arm with a stethoscope, no sound is heard and no raidal pulse is felt.



CHARACTERISTICS OF THE AUSCULTATORY METHOD OF MEASURING BLOOD PRESSURE

An appropriate sized cuff is placed on right upper arm. Pressure in the cuff is first inflated above the level of systolic pressure in the aorta which collapses the artery, and as one listens over the brachial artery in the arm with a stethoscope, no sound is heard and no radial pulse is felt.

The cuff is then slowly deflated (2-3 mm Hg/sec) and as soon as the systolic pressure is reached, a small spurt of blood passes beneath the cuff during each systole, producing a snapping sound (Phase I of Korotkoff sound) due to turbulence and closure of the vessel. As soon as this sound is audible, the systolic pressure is noted.

As the cuff is then further deflated, the sounds change in character and intensity, and the flow becomes continuous, at which point the sound (Phase V of Korotkoff sound) disappears and the diastolic pressure is recorded.

As per the latest recommendation of working group, National High Blood Pressure Education Program (1996), Phase I is the index of systolic pressure and Phase V, diastolic pressure[2].

Flush Method

It is usually used to measure BP in newborn. Appropriate sized cuff is applied to the arm and the corresponding forearm, and fingers are compressed with elastic bandages or a rubber glove. Wrapping should begin with tip of the digits working proximally to the lower edge of the cuff.

Following compression, the cuff is inflated to 100mg Hg and the wrapping removed. The point at which the flushing appears is noted. This reading gives the mean arterial pressure.

Doppler Method

Doppler principle is used to measure BP and cardiovascular abnormalities. The mean systolic blood pressure obtained with the doppler technique correlated well with the direct measurement.

Doppler apparatus is a light weight battery operated portable instrument for measuring blood pressure rapidly and accurately even by inexperienced personnel. It is very useful in Newborn nursery.

Oscillometry

This method was introduced in 1964 based on the visualisation of oscillations, transmitted by the arterial pulse to the mercury column in the manometer.

With cuff deflation, the levels at which oscillation appear and disappear are read as systolic and diastolic pressure.

HYPERTENSION AND RISK FACTORS

Definitions

Hypertension

According to fourth report from the national high blood pressure education program (NHBEP) working group on children and adolescent and uptdates of 1996 `update of 1987 task force up in children and adolescents[7].

- Hypertension is defined as average systolic blood pressure (SBP) and / or distolic blood pressure (DBP) that is $\geq 95^{th}$ percentile for gender, age and height on >3 occasions.

- Pre-hypertension in children defind as average SBP of DBP levels that are $\geq 90^{th}$ percentile but $< 95^{th}$ percentile.

- As with adults, adolescents with BP level $\geq$ 120/80 mm Hg should be considered pre hypertensive.

- A patient with BP level $> 95^{th}$ percentile in a physicians office or clinic who is normotensive outside of clinical setting, has "white coat hypertension" Ambulatory BP monitoring (ABPM) is usually required to make this diagnosis.

Overweight and Obesity

Obesity : Body mass index weight in kg divided by the square of the height in meters: kg/m^2 exceeds age gender - specific 95^{th} percentile[8].

Overweight : Body mass index between 85th percentile and 95th percentile[8].

Centres for disease control (CDC) growth charts for obesity was used in the present study.

RISK FACTORS

Risk factor is some thing that increases the likelihood of getting a disease or condition. It is possible to develop hypertension with or without risk factors. However the more the risk factors you have, greater the likelihood of developing hypertension[9].

Specific life style factors

- High salt diet
- High Saturated fat diet
- Lack of exercise
- Poor physical fitness
- Physical Inactivity
- Stress

Medical Conditions

- Obesity
- Overweight
- Other conditions associated with hypertension

  Diabetes

  Renal disease

Hormonal disorders

Porphyria

- Medications

Steriods

Non steroidal antifilammatory drugs

Anti depressants

Age More than 35 years old are at increase risk

Genetic factorsFamily members with high blood pressure increases the risk of developing hypertension in individual.

High salt diet

Under physiological conditions to sustain adequate intravascular volume, kidneys maintain sodium balance. Salt sensitive hypertensive individuals have renal, neurolgic or hormonal regulation of BP and sodium altered.Essential hypertension was divided into high plasma renin and low plasma renin level. In wall sodium concentration leads to increased intracellular concentration. Increased calcium causes increased contractivity and reactivity, thus manifesting as increased vascular tone and peripheral vascular resistance resulting in elevated BP[10].

Physical activity

Regular aerobic activity adequate to achieve atleast a moderate level physical fitness can enhance weight loss and functional health status and reduce risk of cardiovascular disease. When compared with their more active and fit peers, sedentary individuals who are with normal blood pressure have 20-50% increased risk of developing hypertension[8].

Blood pressure can be lowered with moderately intense physical activity (40-60% of max oxygen consumption) such as making 30-45 min of brisk working most days of the week.

Americal Heart Association recommends atleast 30min of aerobic exercise for most days of the week.

Obesity and Overweight

Excess body weight is closely correlated with increased blood pressure. The deposition of excess fat in the upper part of one body (Visceral or abdominal) as evidenced by a waist circumference also associated with risk of hypertension, dyslipidemia, diabetes and coronary heart disease mortality[8].

Weight reduction, as little as 10 pounds (4.5kg) reduces blood pressure in large proportion of overweight with hypertension weight reduction blood pressure lowering effect of concurrent antihypertensive agents and can significantly reduce concomitant cardiovascular risk factors, such as diabetes and dyslipedemias.

Obesity related hhyertension is a state of high cardiac output, increased intravascular volume, increased symptomatic nervous system activity, sodium retention and hyperinsulinemias.

Other Dietary Factors

Dyslipidemia is a major independent risk for coronary artery disease, therefore dietary therapy and necessary drug therapy for dyslipidemias are an important adjunct to antihypetensive treatment. Large amount of omega acids may lower blood pressure.

Caffeine may raise blood pressure actively tolerance to this pressure effect develops rapidly and no direct relationship between caffeine intake and HT has been found in most surveys[8].

REVIEW OF LITERATURE

Report on Second Task Force in Blood Pressure Control in Children - 1987 (USA)[1] developed normative blood pressure data for children and adolescents at Bethesda. It reports approximately 5% of children fall beyond 95th percentile for systolic and diastolic blood pressure. On reexamination only, 1% of the original group had persistently elevated systolic and diastolic blood pressure.

For determination of blood pressure, Korotkoff Phase I was taken as systolic pressure and Korotkoff Phase IV as diastolic pressure.

Update on the 1987 Task Force Report - 1996 (USA)[2] - A working group report from the National High Blood Pressure Education Program provides new normative BP tables for children and adolescents which included height percentiles, age and gender.

It recommends the determination of proper cuff size. The cuff bladder width should be approximately 40% of the circumference of the arm measured at a point midway between the olecranon and acromion. The cuff bladder should cover 80% to 100% of the circumstances of the arm.

Blood pressure should be measured with cubital fossa at heart level. The arm should be supported. The stethoscope bell is placed over the brachial artery pulse, proximal and medial to the cubital fossa, below the bottom edge of the cuff.

The fifth Korotkoff sound is now used to define diastolic BP in children and adolescents.

Sol Londe MD[10] Studied blood pressure in 894 boys and 911 girls from the age 4 through 14 years in St.Louis (USA). He reported that mean SBP in boys rises steadily from 98 mm Hg at 4 years to 125 mm Hg at 15 years.

In girls, it rises from 98 mm Hg at age 4 of a highest value of 121 mm Hg at ages 11 and 13 years. There was no significant difference between the sex except at age 11 where it is 7 mm Hg higher for girls and at the age of 15 years it is 10 mm Hg higher for boys.

He reported that 111 boys (12.4%) and 106 girls (11.6%) had blood pressure above the 90th percentile.

Clausen LR et al.,[11] measured blood pressure of school children in Denmark using three different cuffs, 6 x 20 cm, 9 x 27 cm and 12 x 35 cm. Ideal cuff size in each pupil was defined as the one in which the width of the bladder was closest to 40% of arm circumference.

Elkasabany AM et al.,[12] reported at New Orleans in USA, that during childhood K is a more reliable measure of diastolic blood pressure than K. K diastolic pressure measured in childhood is a better predictor of adult hypertension.

Leccia G, et al.,[13] studied the influence of body size, body fat and sexual maturation on blood pressure in 190 adolescents in Italy. They concluded that body size appears to be a major determinant of blood pressure whereas sexual maturation seems to influence blood pressure levels mainly through body growth.

The influence of percent body fat on blood pressure setting seems to be of limited importance.

Lauer RM et al.,[14] reports children and adults who are obese may have elevated BP and recommends all obese children should have blood pressure determination obtained longitudinally.

Freedman DS et al.,[15] reports that approximately 20% to 30% of obese children have elevated blood pressure, obese children have a 2.4 fold risk for elevated blood pressure compared with controls.

Chadha SL et al.,[16] studied distribution pattern of blood pressure in a randomized sample of 10215 school children (5709 boys and 4506 girls) from 5 years through 14 years in Delhi. The mean values of systolic and diastolic blood pressure increased with age in both sexes.

The cut off points for high blood pressure were based on average SBP and / or DBP values of 95 percentile or greater for each age.

The values for SBP ranged from 70 mm Hg to 140 mm Hg and for DBP from 36 mm Hg to 100 mm Hg for the age group 5 - 9 years. In the age group 10 - 14 years, the values for SBP and DBP ranged from 72 mm Hg to 160 mm Hg and from 46 mm Hg to 120 mm Hg respectively.

The prevalence of hypertension was 11.9% in boys and 11.4% in girls, an insignificant difference.

Anthropometric variables like height, weight and BMI showed positive correlation with SBP as well as DBP.

Agarwal VK, et al.,[17] studied blood pressure in 2645 children between 3 - 15 years of age in Allahabad. Both systolic and diastolic BP were found to have direct correlation with weight but not with height.

There were no significant differences of blood pressure between males and females and between upper and lower socio economic status.

Overall incidence of hypertension was 1.8%. Out of this 0.52% were systolic hypertension, 0.52% were diastolic hypertension. In 0.76% cases both systolic and diastolic blood pressure were raised.

Sharma BK et al.,[18] calculated blood pressure percentiles for each age group in Chandigarh. Both systolic and diastolic blood pressure had a positive correlation with age, height, weight, and body surface area ($P < 0.01$).

The upper limits of normal (90th Percentile) systolic / diastolic pressure were 113/74, 119/76 and 126/79 in children aged 7 - 9 years, children aged 10 - 12 years and adolescents aged 13 - 16 years respectively.

Anand NK and Lalit Tandon[19] reported that the rise of blood pressure was directly proportional to the increase in age with a spurt in SBP at the age of 12 years in both the sexes. He reported that hypertension was observed only in 0.46% children and obesity and family history of hypertension were found to be important influencing factors in the development of hypertension.

Gupta AK and Ahmad AJ (Aligarh)[20] found that family history of obesity, hypertension or myocardial infarction and / or stroke was met with in significantly higher ($P < 0.001$) number of children with sustained hypertension as compared to normotensive students.

Chadha SL et al.,[21] performed a cross sectional survey of 8293 school children in the age group 5 to 14 years in Delhi. The first and the fourth Korotkoff sounds were taken as indicative of the systolic and the diastolic blood pressure respectively.

Age and height, but not gender emerged as the principal determinants of systolic and diastolic blood pressure. Age and height specific 90th and 95th percentile values of systolic and diastolic pressure were estimated and they categorized children into `normal', `high normal' and `high' blood pressure groups.

Chan PW et al.,[22] recorded BP for 1756 healthy school chidlren aged 6 - 12 years. Korotkoff I represented the SBP and Korotkoff V was taken as the DBP.

BP percentile charts were drawn up based on age group and sex regardless of ethnicity. There was a significant correlation between both SBP and DBP to increasing height, weight and BMI.

Laroia D et al.,[23] derived mean figures for SBP and DBP with standard deviation and 95th percentile charts for each age group from 5 years through 14 years. SBP and DBP for both sex had direct correlation with age, height and weight. Overall incidence of hypertension was found to be 2.93%.

Madivannan, et al.,[24] studied Blood pressure in 2002 children between 6 - 12 year of age in Chennai. Both systolic and Diastolic BP were found to have direct correlation with height and weight. There was statistically significant difference of mean systolic and Diastolic pressure observed between low and high socio economic groups.

Overall prevalence of hyeprtension was 9.54%. Prevalence of obesity was 0.69% and prevalence of HT in obese children was 64.29% BMI more than 25 considered as obesity in this study.

Muthu Kumar, et al.,[25] studied blood pressure in 2400 children between 6 - 17 years of age, 1200 boys and 1200 girls. There was statistically significant difference of systolic and diastolic pressure observed between high and low socio economic status. Mean systolic and diastolic blood pressure showed lineal relationship with increase in weight and height.

Overall prevalence of hypertension was 5.41%. Prevalence of hypertension in obese children was 20.8% as compared to 4.6% in non obese children.

Bishav Mohan et al.,[26] studied 2467 students between 11 - 17 years from urban area and 859 students from rural area.

Prevalence of hypertension in urban area 6.69% compared to rural area 2.56%. This was significant difference between urban and rural population in obesity and overweight prevalence in urban obesity and overweight was 2.35% and 11.3%, in rural area it was 3.63% and 4.7% respectively.

JUSTIFICATION OF THE STUDY

Significance of blood pressure measurement in children is well recognised. Considerable work has been done to establish the normal blood pressure for various groups, although little has been done with reference to blood pressure in children.

Blood pressure tracking studies suggest that hypertension in adulthood often has its origin in childhood. Indeed, blood pressure in childhood is the best predicter of hypertension in later life. Awareness of this fact has resulted in the incorporation of BP measurement in routine paediatric health care practice. However the interpretation of blood pressure in children is not simple.

Changing life style, food habits towards junk foods and fast foods and sedendary life style contribute to increased risk of obesity, overweight and hypertension.

Therefore this study was done to screen for asymptomatic hypertension between 10 - 17 years old school children and to assess the modifiable and non modifiable risk factors. The criteria laid down by the Update of the second task force USA 2004 on BP in children have been used in our study.

AIM OF THE STUDY

To Identify

Prevalence of

(a) Asymptomatic hypertension .

(b) Obesity

(c) Overweight among school children between 10 - 17 years in Chennai City.

To Assess

- Association of risk factors like age, sex, obesity, overweight, socio economic status, physical activity, hours of watching television, oil consumed, family history of hypertension, family Ho. Diabetes mellitus, to hypertension among these children.

SUBJECTS AND METHODS

METHODOLOGY

Study Design	:	Cross Sectional Survey / Case control study.
Place of Study	:	Middle Schools, high schools and higher secondary schools that belong to the corporation of chennai and private schools in Chennai.
Duration	:	July 2004 - Feb. 2006, 1 year 7 months
Inclusion cirteria	:	All healthy school children in the age group 10 - 17 years.
Exclusion criteria	:	Those with known cardiac or renal disease and those on medications which are likely to influence BP.
Sample Size	:	For an existing prevalence of 5% with 20% precision accuracy 99% confidence interval sample size is 2945
Cases	:	Children with Hypertension
Control	:	Children with Normal Blood Pressure

Risk factors

1. Sex
2. Obesity
3. Overweight
4. Family history of hypertension
5. Family history of diabetes melitus
6. Physical activity
7. Oil consumption in Kg per head / month.
8. Hours of watching television
9. Socio economic status.

Sex : - Males are at higher risk for hypertension

Obesity and overweight

Are at highrisk of geting hypertension. Obesity is taken as BMI > 95th Percentile Centre for Control of Disease chart. Over weight body mass Index between 85th to 95th percentile of Centre for Control of disease chart.

Family History of Hypertension and Diabetes

Children with family history of hypertension and diabetes are at higher risk of developing hypertension than children with a negative history.

Physical activity

Less than 30 min for more days a week were at higher risk for obesity and indirectly to hypertension than children who have > 30 minutes of physical activity.

Oil consumption

Dyslipedemias in an important risk factor, increased saturated fat in food is a risk factor, since detailed dietary history of the children was not taken and percentage of calories obtained from fat was not calculated, oil consumed per month was grossly taken as a risk factor. Median value for oil consumption was calculated in kg per month the median value was 0.75Kg. More than the 0.75 Kg was taken as a risk factor.

Hours of watching Television

During watching television in associated with intake of junk food and increased risk of obesity and overweight hence indirectly to hypertension this was taken as a risk factor. Median value of hours of watching television was calculated in minutes. The median value was 60 min. Child watching television for more than 60 min was taken as risk factor.

Socio economic status

Assuming obesity prevalence is higher in higher socioeconomic status than lower which indirectly predisposes to hypertension. Score of less than or equal to 15 lower socio economic status and More than 15 higher socio economic status according to Modified Kuppuswamy Scale.

MANOEUVRE

Blood Pressure Measurement

Method Used : Auscultatory method with standard mercury sphygmomanometer

Stethoscope : Bell of the stethoscope

Cuff Size : Bladder width should be approximately 40% of arm circumference at mid point of ole crenon and acromion, bladder cuff length should cover 80 - 100% of circumference of arm.

Mid Arm Circumference	Bladder Width
12 - 15 cm	6 cm
16 - 20 cm	8 cm
21 - 25 cm	10 cm
26 - 30 cm	12 cm

Position : Sitting

Limb in which BP recorded : Right upper limb

Systolic Pressure : First Korotkoff sound

Diastolic Pressure : Fifth Korotkoff sound (Complete disappearance)

No. of measurement : 3

Height measurement

Stadiometer was used to measure the height. Child was made to stand bare footed, heels, buttock, shoulders and occiput touching the rod and looking straight ahead. The chin should be straight (Frankfurt Plane). The measurements were read after directly lowering the cursor, hair made completely flattened. Accuracy to the nearest 0.5 cm.

Weight measurement

Using bathroom scale weight was measured, after shoes were removed and with little clothing as custom permits. New error was checked after each measurement Accuracy to the nearest 500g.

Mid Arm Circumference

Measurement done in right upper arm, midway between the acromion and the olecranon. the measuring rope is held gently without pressing the soft tissues. The reading accuracy to the nearest 0.1 cm. The tape was checked for flexible, not stretchability regularly.

Blood Pressure Measurement

After obtaining permission from Head of the selected schools, the children were examined. The procedure was explained to all children in a language understandable to them in the presence of the teacher and the care was taken to reduce the anxiety. Individual verbal consent was taken from every child. Girl children were examined in the presence of lady doctors.

All children who were included in the study were subjected to thorough clinical examination and presence of cardiac and renal diseases were ruled out. Femoral artery pulse was routinely palpated to rule out coarctation of aorta.

Ascultatory method was used to record blood pressure with a standard mercury sphygmomanometer. The accuracy of the instrument was periodically checked.

Mid arm circumference was measured in the right upper arm and appropriate sized cuff was chosen and tied over the right upper arm. The right brachial artery pulse was routinely palpated and used for recording blood pressure as it is a direct continuation from the ascending aorta.

With the child sitting comfortably in a proper chair with back rest and with the cubital fossa supported at the heart level, the cuff was inflated at a pressure approximately 20 mm Hg higher than at which the radial pulse disappears.

The bell of the stephoscope was placed over the brachial artery proximal and distal to the cubital fossa below the bottom edge of the cuff and the cuff was deflated at a rate of 2 - 3 mm Hg/sec.

The appearance of `tapping' first korotkoff sound and complete disappearance of sound was taken as systolic and diastolic blood pressure respectively. Three readings were taken at the internal of 1/2 - 1 hr and child detected hypertension referred for further evaluation, after cross checking by another doctor.

Socio - economic status was assessed on the basis of socioeconomic status - urban scale by kuppusamy (1997 - 1998). It was classified into upper socioeconomic class (total scale > 15) and lower socio economic class (total score <15) for this study.

Hours of aerobic physical activity per day and per week, amount of oil consumed per head per month, hours of watching television, family history of diabetes, family history of hypertension as listed in the questionnaire were asked and noted (Annexure - I).

Statistical analysis

To examine the determinants of hypertension among socio-economic-demographic, anthropometrics, history of hypertension, diabetes sex, obesity, overweight physicalactivity, oil consumption, hours of watching television univariate and multivariate analysis (Logistic regression) were performed. The unadjusted and adjusted odds ratio were computed for hypertension with other risk factors collected in the study. All analysis were two-tailed and a P-value <0.05 was considered statistically significant. Statistical analysis was performed using SPSS version 10.0 package.

OBSERVATIONS

The total number of school children examined was 3906. Among them 1799 were boys and 2107 were Girls.

Category	Number
Total Number of school children examined	3906
Total Number of Boys	1799
Total Number of Girls	2107
Boys from high Socio Economic Status	872
Boys from low Socio Economic Status	927
Girls from high Socio Economic Status	967
Girls from low Socio Economic Status	1140

The total number of school children examined from low socio economic status was 2067 children. Among them 927 were boys and 1140 girls.

The total number of school children from high socio economic status was 1839. Among them 872 were boys and 967 were girls.

Table - I

Prevalence of Hypertension among male 10 - 17 years old

Age Yrs	Total Population Screened	Systolic HT	Diastolic HT	Systolic and Diastolic HT	Total HT	% of HT
10.	226	9	5	3	17	7.5%
11.	216	7	6	2	15	6.94%
12.	240	12	7	4	23	9.56%
13.	226	10	4	5	19	8.40%
14.	230	14	6	3	23	10%
15.	222	8	8	6	22	9.9%
16.	224	9	5	3	17	7.6%
17.	215	2	1	5	8	3.8%
Total	1799	71 (49%)	42 (29%)	31 (22%)	144 (100%)	8.0%

HT : Hypertension

Table - II

Prevalence of Hypertension Among Females 10 - 17 years

Age Yrs	Total Population Screened	Systolic HT	Diastolic HT	Systolic and Diastolic HT	Total HT	% of HT
10.	259	3	11	7	21	8.1%
11.	270	9	6	5	20	7.4%
12.	270	9	10	13	32	11.9%
13.	268	10	15	11	36	13.4%
14.	265	9	10	14	32	12.08%
15.	265	12	11	5	28	10.57%
16.	260	5	25	4	34	13.07%
17.	250	4	18	2	24	9.6%
Total	2107	60 (26.4%)	106 (47%)	61 (26.6%)	227	10.7%

HT : Hypertension

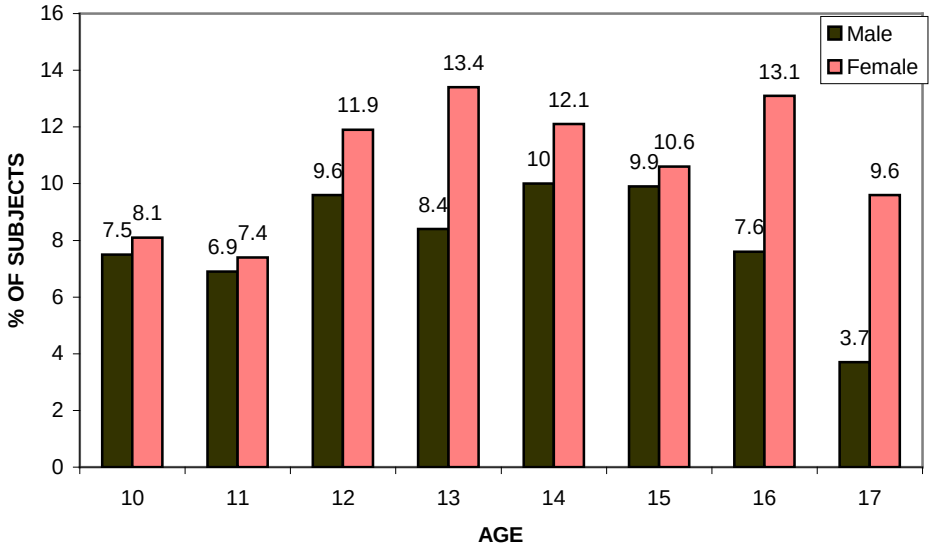


Fig. 1 HYPERTENSION BY AGE AND GENDER

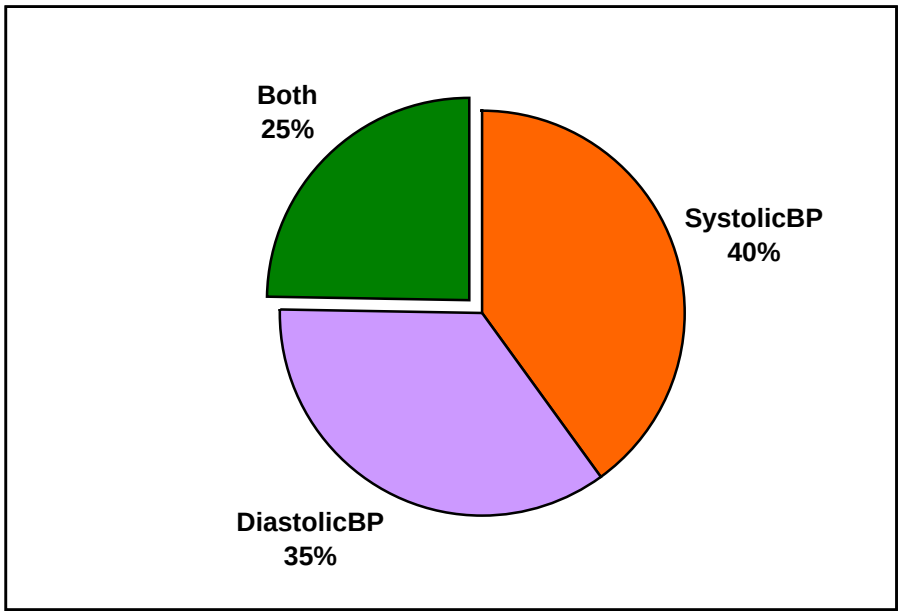


Fig. 2 HYPERTENSION

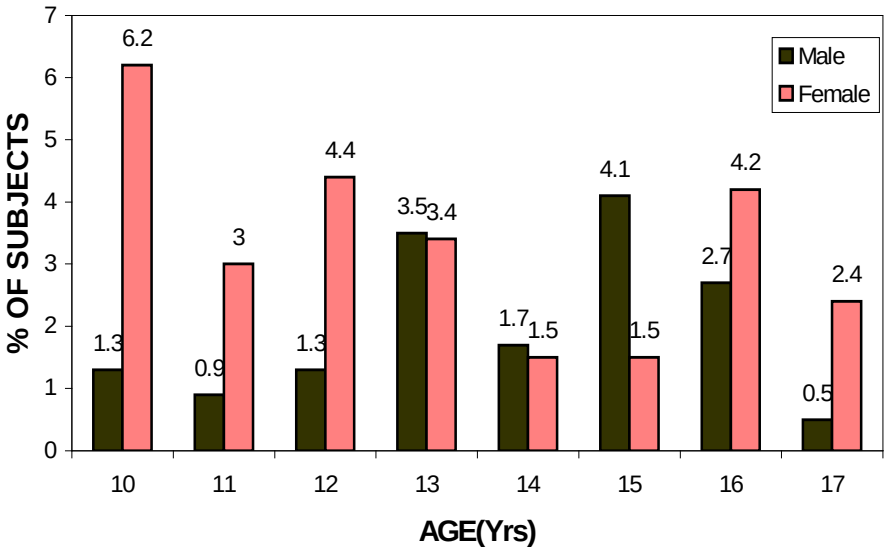


Fig. 3 OBESITY VERSUS AGE AND GENDER

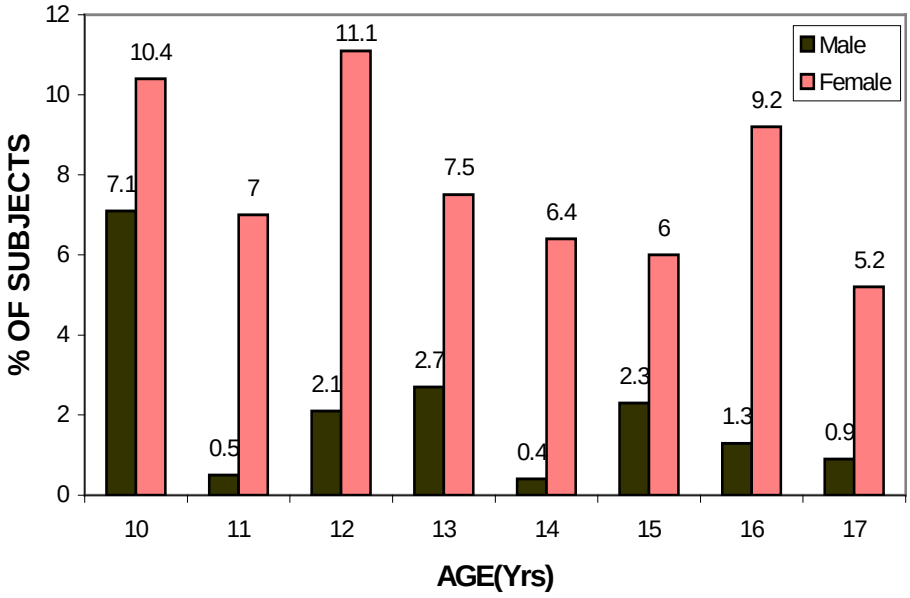


Fig. 4 OVER WEIGHT VERSUS AGE AND GENDER

The over all prevalence of hypertension is 9.5% (371 Hypertension children out of 3906 children studied).

Among males, the prevalence of hypertension was 8.0% (144 of 1799 children) with a peak prevalence around 12 to 15 years of age.

Isolated systolic hypertension was observed 71 cases out of 144 children with hypertension (49%) and diastolic hypertension in 42 cases of 144 with hypertension children (29%). Children having both systolic and diastolic hypertension were 31 out of 144 (22%) (Table I).

Among females the overall prevalence was 10.8% (227 out of 2107 children) with a peak prevalence around 12 to 16 years of age. Isolated systolic hypertension 60 cases (26.4%), diastolic hypertension alone 106 cases (47%) and children having both systolic and diastolic hypertension in 61 cases (26.6%) (Table II).

Obesity had an over all prevalence of 2.7% (106 out of 3906) and among hypertensives 8.35% (31 Out of 371) and among non hypertensives it was 2.1% (75 out of 3535 children). Obesity among males was 2.00% (36 out of 1799 children). Among females is was 3.32% (70 out of 2107 children). (Fig.3).

TABLE - III

RISK FACTORS FOR HYPERTENSION AMONG 10 - 17 YEARS OLD - UNIVARIATE ANALYSIS

Sl. No.	Risk Factor		Cases		Control		OR (95% CI)	p value
			n	%	n	%		
1.	Sex	Female	227	10.8	1880	89.2	1.388 (1.115 -1.727)	0.004
		Male	144	8.0	1655	92		
2.	Socio Economic status	Upper	188	10.2	1651	89.8	1.172 (0.946-1.452)	0.161
		Lower	183	8.9	1884	91.1		
3.	Over weight	Yes	35	17.1	170	82.9	2.062 (1.409-3.017	0.000
		No	336	9.1	3365	90.9		
4.	Obesity	Yes	31	29.2	75	80.8	4.206 (2.728-6.486)	0.000
		No	340	8.9	3460	91.1		
5.	Family History of Hypertension	Yes	49	14.2	296	85.8	1.665 (1.205-2.301)	0.002
		No	322	9.0	3239	91		
6.	Family History of Diabetes mellitus	Yes	20	13.7	126	86.3	1.542 (0.950-2.502)	0.105
		No	351	9.3	3409	90.7		
7.	Physical Activity	<30 min	115	9.8	1064	90.2	0.959 (0.761-1.209)	0.770
		>30 min	256	9.4	2469	90.6		
8.	Hours of watching television	>60 min	70	10	627	90	1.079 (0.820-1.419)	0.638
		<60 min	301	9.4	2908	90.6		
9.	Oil consumption per month	>0.75kg	123	10	1111	90	1.082 (0.862-1.359)	0.534
		<0.75kg	248	9.3	2424	90.7		

Overweight has an over all prevalence of 5.25% (205 out of 3906 children), among non hypertension overweight prevalence was 4.8% (170 out of 3535 children) and among hypertension it was 9.43% (35 out of 371 children). Overweight among males was 2.17% (39 out of 1799 children) and among female it was 7.87% (166 out of 2107 children) (Fig.4).

Family history of hypertension among hypertensives was 13.2% as compared to non hypertensives which was 8.3%. Family history of diabetes mellitus among hypertensives was 5.3% as against non hypertensive children who had a positive history in 3.6%.

Prevalence of hypertension among lower socio economic children was 8.85% as against a prevalence rate of 10.2% among children belonging to high socio economic status children

Children with hypertension were 4 times more likely to be obese when compared with children with normal BP. [OR (95%CI) : 4.20 (2.728 - 6.486)] (Table. III).

Children with hypertension were 2 times more likely to over weight when compared to children who are normotensive[OR (95% CI) : 2.062 (1.409 - 3.017)] (Table. III).

Children with hypertension were 1.6 times more with family history of hyperentsion when compared to children with no normal BP [OR (95%CI) : 1.665 (1.205 - 2.301)] (Table. III).

Children with hypertension were 1.3 times more likely to be females when compared to children who are normotensive[OR (95%CI) : 1.388 (1.115 - 1.727)].

Other risk factors were not found to be significant by univariate analysis.

Table IV

RISK FACTORS FOR HYPERTENSION IN CHILDREN AGED 10 - 17 YEARS OLD - MULTIVARIATE ANALAYIS

	SE	df	Sig.	OR	95% CI	
					Lower	Upper
Family H/o HT	.170	1	.002	1.677	1.203	2.339
Obesity	.225	1	.000	4.679	3.009	7.276
Overweight	.199	1	.000	2.179	1.475	3.220
Sex	.115	1	.057	1.246	0.994	1.562

The factors which were found to be significant by univariate analysis were included for multivariate analysis. Family history of hypertension [OR (95% CI)] [1.677 (1.203 - 2.399)], obesity [OR (95% CI)] [4.679 (3.009 - 7.276)] and overweight [OR (95% CI)] [2.179 (1.475 - 3.220)] were found to be independent risk factor to be associated with hypertension in the children studied.

DISCUSSION

The dividing line for hypertension was described by Master et al[28]. as above 95th percentile and by Dube et al.[27] + 2 S.D. above mean.

Presently, National High Blood Pressure Education Programme (NHBPEP) working group on high Blood Pressure in children and adolescent. The fourth report on diagnosis, evaluation and treatment of high blood pressure in children adolescent 2004 an authentic source of child hood and adolescent hypertension 2004. In this report blood pressure is classified into three categories based on percentile values.

Normal	Average SBP and DBP below 90th percentile for age and sex.
Pre hypertension	Average SBP and DBP between 90th and 95th percentile for age and sex-warrant further observation and consideration of the risk factors.
Hypertension	Average SBP and/or DBP of 95th percentile or higher for age and sex-repeated measurements are indicated.

In our study, hypertension was adjoined as per recommendation of NHBPEP 2004 update of second Task force (USA). Other authors have reported a varied range of criteria . (Table V)

Table - V

Prevalence of hypertension in children as observed by other investigators

Study	A.K.Gupta et al.,[20]	NK. Anand et al., [19]	Madivanan et al.,[24]	Chada et al.,[21]	Muthu Kumar et al.,[25]	Present study
Year	1990	1994	1997	1999	2002	2004
Age Group	5 - 15 years	5 - 17 years	6 - 12 years	5 - 14 years	6 - 17 years	10 - 17 years
Criteria (Cut of line)	> 2SD above mean age and Sex	> 2SD above mean for age	> 2SD above mean for age	≥ 95th percentile	≥ 95th percentile	≥ 95th percentile
Prevalence	0.41%	0.46%	11.24%	11.7%	5.41%	9.5%

This diversity in results may be due to varying age groups taken for study and different criteria adopted for defining hypertension and basic difference between racial subgroups related to geographic, dietary and cultural factors.

In the present study, there were more number hypertension among females children. 10.8% among females children as when compared to male who had a prevalence of about 8.0% which does not corelate with other studies Chada et al report hypertension 11.9% male and 11.4% among girls[21]. The reason could be due to increased prevalence of overweight (7.87%) and obesity (3.32%) among female children when compared to overweight (2.17%) and obesity (2.00%) in males.

Obesity prevalence was 2.7% in present study which is more than the prevalence of the study done by Anand et al, which is 0.45%. The possible reason for the increased prevalence could be changing life style over 9 year period and dietary pattern different for our community population and for study done by Anand et al[19].

Positive family history, diabetes mellitus among hypertensives was 5.3% as against non hypertensives 3.6% which was similar to the study of Chada et al[21] were it was 5.4% among hypertensives against 3.1% among non hypertensives.

Children with obesity having hypertension was seen in 8.35% which is twice the observation (3.5%) made by Anand et al[19] but considerably less than 3.5% observed by (43.10%) Bishav et al[26] Positive family history of hypertension was seen in 8.3% which is less than the observation (20.4%) by Chada et al[21] .

Statistically significant risk factors for hypertension among children aged 10 - 17 years old by univariate analysis were obesity, overweight and positive family histology of hypertension in the present study, which correlated with the study of Anand et al[19]., and Chada et al[21] in certain factors which are obesity and positive family history, overweight as risk factor for hypertension was not done in the study by Anand et al[19] & Chanda et al[21] since BMI >25 was taken as criteria for obesity and 85th to 95th percentile overweight population level was not estimated in the past studies.

SUMMARY

- Prevalence of Hypertension is 9.5%, among males prevalence is 8.0% and among females it is 10.8%.

- Prevalence of hypertension among lower socio economic status children is 8.85% as against prevalence rate of 10.2% among children belonging to high socio economic status.

- Overall prevalence of obesity is 2.7%, among females prevalence is 3.32% and along males prevalence it is 2.00%.

- Prevalence of overweight is 5.25%, among female overweight prevalence is 7.87% and among male it is 2.17%.

- Obesity, overweight and family history of hypertension are found to be significant independent risk factors for hypertension among 10 - 17 years old children.

CONCLUSION

- Since the prevalence of asymptomatic hypertension seems to be significant (9.5%) among 10 - 17 years old children. It is mandatory to check the blood pressure atleast once a year in school children. It will be a useful guide for early identification and evaluation of hypertension in later life.

- Since the prevalence of obesity (2.7%) and overweight (5.25%) seems to be significant and associated with increased risk of hypertension, life style modification in the form of dietary habits like restricted salt intake, avoiding junk food consumption and oil food stuffs, Increased physical activity and relaxation techniques will decrease the overweight and obesity and indirectly influence to maintain the blood pressure in the normal range. The potential pay off by way of prevention is enormous in terms of later cardiovascular disease and allow the provision of more comprehensive care to the pediatric population.

ANNEXURE

PROFORMA

Name :

Age :

Sex :

School Name :

Fathers Education / Income / Occupation :

Mothers Education / Income / Occupation :

Total Members in the Family :

Family History of Hypertension : Yes / No

Family History of Diabetes Melitus : Yes / No

Hours of Watching Television / day : in minutes

Hours of Playing / Day : in minutes

Number of Playing days / Week :

Type of Games played :

Amount of Oil Purchased Per month :

Past History of any medical illness:

H/o. decreased urine output / pedal edema / haematuria:

H/o. palpitation / headache / abdominal swelling:

H/o. recurrent urinary tract infection:

MEASUREMENT

Height (cm)

Weight (cm)

Mid Arm circumference (cm)

Body Mass Index wt in kg / h^2 in m

Blood Pressure 1

2

3

Socio economic status : Total score.

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